

What is claimed is:

1. A solid-state imaging device equipped with plural unit pixels each of which includes a photo-diode and a photo-detector on a substrate, the photo-diode comprising a charge generating region to generate charges upon light irradiation, the photo-detector comprising a charge accumulation region to accumulate the charges transferred from the charge generating region and generating a signal potential that changes in accordance with the amount of the charges in the charge accumulation region, the solid-state imaging device comprising:

10 a charge transfer region provided between the charge generating region and the charge accumulation region of the pixel, the charge transfer region forming a first potential barrier to the charges in the charge generating region, the first potential barrier being removable according to the applied voltage to the photo-detector.

15 2. The solid-state imaging device according to claim 1, further comprising a first charge eliminating region formed between the substrate and the charge accumulating region, the charges in the charge accumulating region being eliminated to the substrate via said first charge eliminating region when a certain voltage is applied to the photo-detector.

20 25 3. The solid-state imaging device according to claim 1, further comprising:

29 a second charge eliminating region formed near the charge

generating region; and

a region, provided between the charge generating region and the second charge eliminating region, that forms a second potential barrier to the charges in the charge accumulating region, the second potential barrier being lower than the first potential barrier such that the charges in the charge eliminating region is overflowed to a surface side, opposite to the substrate, via the second charge eliminating region.

10 4. The solid-state imaging device according to claim 3, wherein the second potential barrier being removable according to the applied voltage to the second charge eliminating region.

15 5. The solid-state imaging device according to claim 1, wherein the charge generating region has one conductive type, same as the substrate, and the photo-diode comprises a first region with opposite conductive type that contacts the charge generating region, and

20 wherein the photo-detector is a field effect transistor and comprises:

a channel region formed on the surfaces of the charge accumulating region with one conductive type and the charge transfer region with opposite conductive type;

25 a gate electrode formed on a gate insulation layer that is formed on the channel region;

a source region having opposite conductive type, the source region near the charge accumulating region being connected to the

channel region; and

a drain region with opposite conductive type that is apart from the source region by the channel region, the signal potential being generated in the source region.

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6. The solid-state imaging device according to claim 5, wherein the plural pixels are arranged in first and second directions to form a matrix, the source regions of the pixels along the first direction being connected to one another, the gate 10 electrodes of the pixel along the second direction being connected to one another, and the drain regions of all pixels being common.

7. The solid-state imaging device according to claim 6, further comprising:

15 a switch circuit capable of electrically connecting and disconnecting the source region and the drain region of the pixel; and

20 a first charge eliminating region formed between the substrate and the charge accumulating region, the charges in the charge accumulating region being eliminated to the substrate via the first charge eliminating region when the potentials of the charge accumulating region and the charge transfer region are increased by boosting up the voltage to the gate electrode,

25 wherein the voltage to the gate electrode is boosted by applying a voltage to the source and drain regions simultaneously while keeping the gate electrode at a high impedance state.

8. The solid-state imaging device according to claim 6,
further comprising:

a second charge eliminating region formed near the charge generating region, the second charge eliminating region having
5 one conductive type; and

a second region with opposite conductive type, provided between the charge generating region and the second charge eliminating region, the second region forming a second potential barrier to the charges in the charge accumulating region, the
10 second potential barrier being lower than the first potential barrier such that the charges in the charge eliminating region is overflowed to a surface side, opposite to the substrate, via the second charge eliminating region.

15 9. The solid-state imaging device according to claim 8,
wherein the second potential barrier being removable according to the applied voltage to the second charge eliminating region.

10. A method of driving the solid-state imaging device
20 according to claim 2, comprising the steps of:

(a) removing the first potential barrier in the charge transfer region to transfer the charged from the charge generating region to the charge accumulating region;

(b) eliminating the charges in the charge accumulating
25 region to the substrate through the first charge eliminating region;

(c) storing the photo-generated charges in the charge

generating region for a predetermined period;

(d) removing the first potential barrier to transfer the charges from the charge generating region to the charge accumulating region;

5 (e) detecting the signal potential of the photo-detector as the first signal potential;

(f) eliminating the charges in the charge accumulating region to the substrate through the first charge eliminating region;

10 (g) detecting the signal potential of the photo-detector as the second signal potential; and

(h) subtracting the second signal potential from the first signal potential to output an image signal.

15 11. The method according to claim 10, wherein the steps (a) to (d) are carried out for all pixels at the same time, and the steps (e) to (h) are carried out for the pixels on a selected line.

20 12. The method according to claim 10, wherein the steps (c) and (d) are repeated in this order.

13. A method of driving the solid-state imaging device according to claim 2, the solid-state imaging device comprising:

25 a second charge eliminating region formed near the charge generating region; and

a region, provided between the charge generating region and

the second charge eliminating region, that forms a second potential barrier to the charges in the charge accumulating region, the second potential barrier being removable according to the applied voltage to the second charge eliminating region,

5 the method comprising the steps of:

 (a) removing the first potential barrier to transfer the charges from the charge generating region to the charge accumulating region;

10 (b) detecting the signal potential of the photo-detector as the first signal potential;

 (c) eliminating the charges in the charge accumulating region to the substrate through the first charge eliminating region;

15 (d) detecting the signal potential of the photo-detector as the second signal potential;

 (e) subtracting the second signal potential from the first signal potential to output an image signal; and

20 (f) removing the second potential barrier of all pixels to eliminating the charges in the charge generating region to the second charge eliminating region while carrying out the steps (b) to (e).